

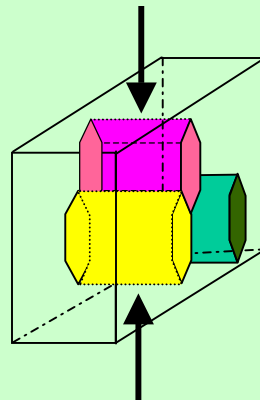
Grain Scale Plastic Deformation in Metals

R. D. Doherty & S. R. Kalidindi, Drexel University, DMR-9612343

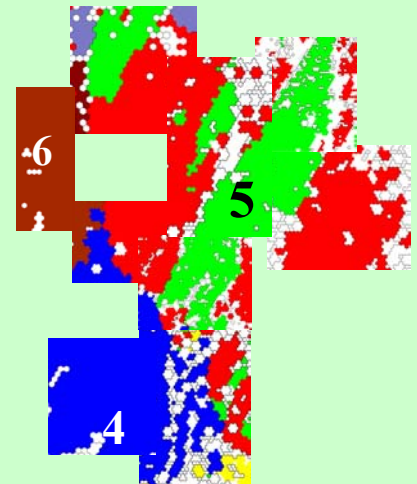
Wrought metallic alloys are used in virtually all load bearing applications, including bridges, cars, airplanes, and buildings. The changes in the underlying microstructure during wrought alloy manufacture play a dominant role in the properties and performance of the final product. Here, we conducted a fundamental study, employing the latest techniques in experimental and numerical methods, aimed at understanding the precise physics controlling the evolution of the microstructure during large plastic strains on metals.

It was observed that orientation and size of the neighboring crystals has a strong influence on the local deformation experienced by a given crystal, and that this can be fully reconciled based on the principle of minimum local and global energy dissipation. These insights are valuable for formulating improved models and simulation tools.

Experiment - plane strain compression on columnar-grained sample



Grain No.5 broke up into two distinct orientations colored "red" & "green"



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Broader Impact:

Strong collaborations were established in this project with several highly reputed international research teams working in this area. These include Professor Van Houtte's research group at Katholieke Universiteit, Leuven, Belgium, Dr. Scott Schoenfeld's group at Army Research Laboratory, Aberdeen, MD, Dr. Landgraf's research group at the Institute of Technological Research, San Paulo, Brazil, and Professor Garmestani's group at Georgia Tech. These interactions have resulted in a large number of archival journal publications and a continuation grant from NSF for further investigations in this important area of research for the metal working industry.

Education:

- **Abhishek Bhattacharya** completed his PhD and is presently conducting postdoctoral studies on related projects at the California Institute of Technology.
- **Jay Young**, a freshman student in College of Information Studies and a STAR scholar, participated in this work. He has developed a user-friendly software that can be used to plot various pole-figures needed for this research. As a result of this interaction, he is considering taking additional courses in materials science and engineering.
- **Dejan Stojakovic** and **Hari K. Duvvuru** are currently pursuing their PhDs in this field of study in a continuation project.